CDS Central Counterparty Clearing Liquidation: Road to Recovery or Invitation to Predation?

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Motivation

- **Dodd-Frank legislation** - standardisation of CDS contracts and mandatory clearing
- **Large, opaque OTC market (11.8 Trillion)** - previously, most CDS bespoke and uncleared.
- **CCP (globally) systemically important institution**
  - Default fund cannot absorb default of more than 1 or 2 large members.
  - CCP pays *variation margin* for life of CDS contract.
- **Lehman Default on CDS contracts** - Clearing facilities left holding large positions (CCP)
  - CCP must sell/unwind positions quickly (5 days), common information.
  - Sold positions to Barclays at large loss.

Research Question

If a large, global dealer bank failed today...

Would a CCP liquidation/unwinding of positions trigger a **fire-sale**, if member banks engaged in predation?

Could this cause a **CCP failure**?

Is there a **CCP Design** which would prevent predation, aid in CCP recovery, and be incentive compatible for both, banks and CCP?

- network problem (star)
- contagion (price-mediated) and amplification (predation)
- multi-bank, multi-asset, multi-period problem

Concept: Covariance Map

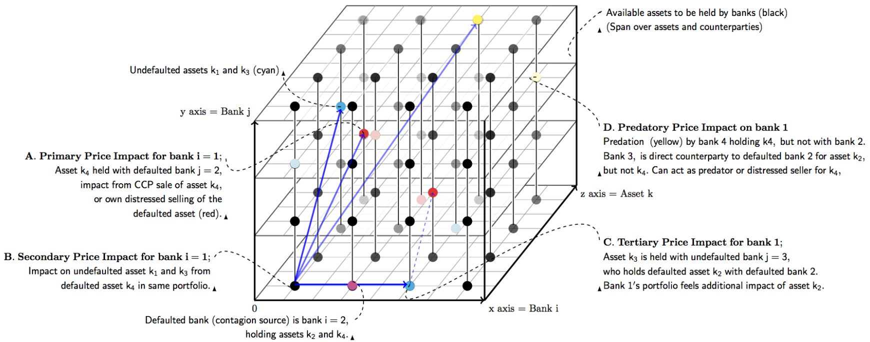

Figure: **Covariance relationships** of banks in terms asset holdings (colour) and of spatial distance to defaulted assets

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The Mathematical Structure I: Reduced Form

- **CDS-Pricing Structure** $\approx$ akin to **taylor-expansion** of the pricing function,

$$V_i^k = X_i^k \triangle S^k(t_\ell)$$

$$= \underbrace{\frac{1}{0!} X_i^k \, \mathbf{F}(X_j^k)}_{\textit{fundamental}} + \underbrace{\frac{1}{1!} X_i^k \, \mathbf{F}'(X_j^k)}_{\textit{primary}} + \underbrace{\frac{1}{1!} X_i^k \, \mathcal{F}'(X_j^k)}_{\textit{predatory}} + \underbrace{\frac{1}{2!} X_i^k \, \mathbf{F}''(X_j^k)}_{\textit{secondary}} + \underbrace{\frac{1}{3!} X_i^k \, \mathbf{F}'''(X_j^k)}_{\textit{tertiary}}$$

- Pricing: Covariance, Price-impact (P), Predation ($\mathcal{P}$), **Liquidation** ($\mathbf{\Gamma_j^k} = \mathbf{a_j^k}\tau$)

$$X_i^k \triangle S^k(t_\ell) = P_0 \; + \; P_1 \, \mathbf{\Gamma_j^k} \; + \; \mathcal{P} \, \mathbf{\Gamma_j^k} \; + \; P_2 \, \mathbf{\Gamma_j^k} \; + \; P_3 \, \mathbf{\Gamma_j^k}$$

$$= \underbrace{[\, X_i^k \triangle S^k(t_{\ell-1}) \,]^+}_{\geq 0} + P_1 \; \underbrace{a_j^k \tau}_{+/-} \; + \mathcal{P} \, a_j^k \tau \; + \; P_2 \, a_j^k \tau \; + \; P_3 \, a_j^k \tau$$

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The Mathematical Structure II: Full Form

Main Proposition: The **variation margin** on a bank's portfolio is determined by the *size* of its positions, X_i^k, and the *degrees* of **covariance relationships** with *liquidated assets* in the market, through the pricing functional, $\triangle S^k$.

$\mathbf{V_i} =$

$$\sum_k X_{ij}^k(\ell\tau)\,\triangle S^k(\ell\tau) = \sum_k \left(X_{ij}^k((\ell-1)\tau) + a_{ji}^k\tau\right)\triangle S^k(\ell\tau)$$

$$= \sum_k \underbrace{\Big\{ [\, X_{ij}^k((\ell-1)\tau)\triangle S^k((\ell-1)\tau)\,]^+}_{fundamental\ cds-spread}$$

$$\textit{primary price impact}\left\{\begin{aligned} &+\underbrace{\left(\sum_{j\in\mathcal{D}}\left|\frac{X_{ij}^k}{X_{ij}^k}\right|X_{ij}^k + \varepsilon\sum_{j'\notin\mathcal{D}}\left|\frac{X_{ij'}^k}{X_{ij'}^k}\right|X_{ij'}^k\right)\sum_{i'=1}^{m}|\triangle S^k((\ell-1)\tau)|\left(\frac{X_{ji'}^k}{D_k}\right)\left(\frac{a_{ji'}^k\tau}{X_{ji'}^k}\right)}_{CCP\ liquidation} \\ &+\Bigg(\underbrace{\sum_{j\in\mathcal{D}}\left|\frac{X_{ij}^k}{X_{ij}^k}\right|X_{ij}^k\sum_{j\in\mathcal{D}}}_{distressed\ selling} + \underbrace{\varepsilon\sum_{j'\in\mathcal{D}}\left|\frac{X_{ij'}^k}{X_{ij'}^k}\right|X_{ij'}^k\sum_{j\notin\mathcal{D}}}_{distress/predation}\Bigg)|\triangle S^k((\ell-1)\tau)|\left(\frac{X_{ij}^k}{D_k}\right)\left(\frac{a_{ij}^k\tau}{X_{ij}^k}\right)\end{aligned}\right.$$

$$+\underbrace{\varepsilon\sum_{j=1}^{m}\left|\frac{X_{ij}^k}{X_{ij}^k}\right|X_{ij}^k\sum_{j'\notin\mathcal{D}}\sum_{i'=1}^{m}|\triangle S^k((\ell-1)\tau)|\left(\frac{X_{j'i'}^k}{D_k}\right)\left(\frac{a_{j'i'}^k\tau}{X_{j'i'}^k}\right)}_{predation}$$

$$+\underbrace{\left(\frac{1}{2!}\right)\left(\left(\frac{3}{2!}\right)\sum_{j\in\mathcal{D}}\left|\frac{X_{ij}^k}{X_{ij}^k}\right|X_{ij}^k + \sum_{j'\notin\mathcal{D}}\left|\frac{X_{ij'}^k}{X_{ij'}^k}\right|X_{ij'}^k\right)\sum_{k'}\sum_{j=1}^{m}\left|\frac{X_{ij}^{k'}}{X_{ij}^{k'}}\right|\sum_{i'=1}^{m}|\triangle S^{k'}((\ell-2)\tau)|\left(\frac{X_{ji'}^{k'}}{D_{k'}}\right)\left(\frac{a_{ji'}^{k'}\tau}{X_{ji'}^{k'}}\right)}_{secondary\ price\ impact}$$

$$+\underbrace{\left(\frac{1}{3!}\right)\left(\left(\frac{9}{3!}\right)\sum_{j\in\mathcal{D}}X_{ij}^k\sum_{k''=1}\left|1-\frac{X_{ij}^{k''}}{X_{ij}^{k''}}\right| + \sum_{j\notin\mathcal{D}}X_{ij}^k\sum_{k''=1}\left|1-\frac{X_{ij}^{k''}}{X_{ij}^{k''}}\right|\right)\sum_{i'=1}^{m}|\triangle S^{k''}((\ell-2)\tau)|\left(\frac{X_{ji'}^{k''}}{D_{k''}}\right)\left(\frac{a_{ji'}^{k''}\tau}{X_{ji'}^{k''}}\right)}_{tertiary\ price\ impact}\Big\}$$

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Computational Difficulty

Simulation incorporates...

- **Network:** 1 CCP, 14 banks, mutually holding 100 CDS assets.
- **Variation:** number of distressed banks (holding contagion asset)
- Comparison of Two Guarantee Fund Structures:
  - **Pure Fund**: Guarantee fund proprietary, Default fund is for risk-sharing.
  - **Hybrid Fund**: Guarantee Fund and Default fund are for risk-sharing.
- **Three Trading Periods:** Liquidation, Buyback and Recovery
- **Three Market Liquidity Scenarios:** Healthy, Decreasing and Crisis

Simulation Results I: Default Distribution based on Market Depth

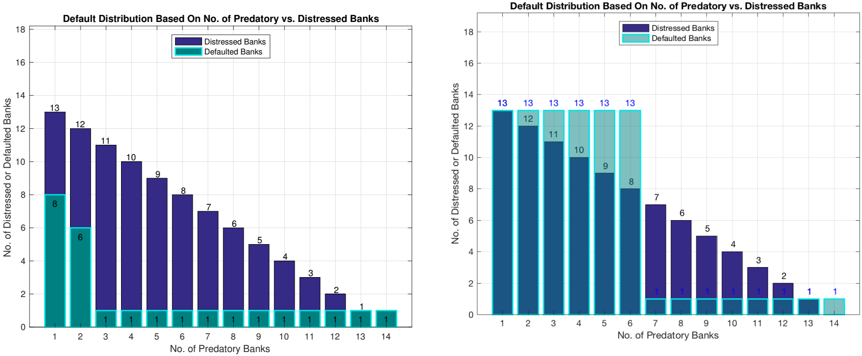

Figure: Under Normal Market Liquidity & Decreasing Market Liquidity

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Simulation Results II: Final CCP Loss based on Market Depth (1)

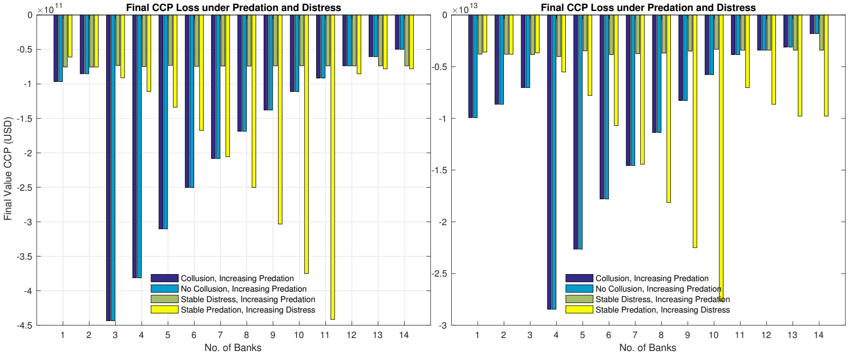

Figure: Under Normal Market Liquidity & Financial Crisis Market Liquidity

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Simulation Results III: Final CCP Loss based for Decreasing Market Depth

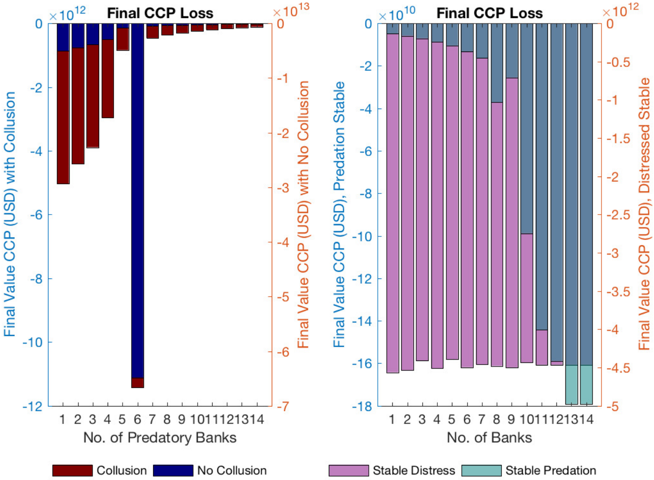

Figure: Under Decreasing Market Liquidity

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Simulation Results IV: Predation Profits & Margin Refill

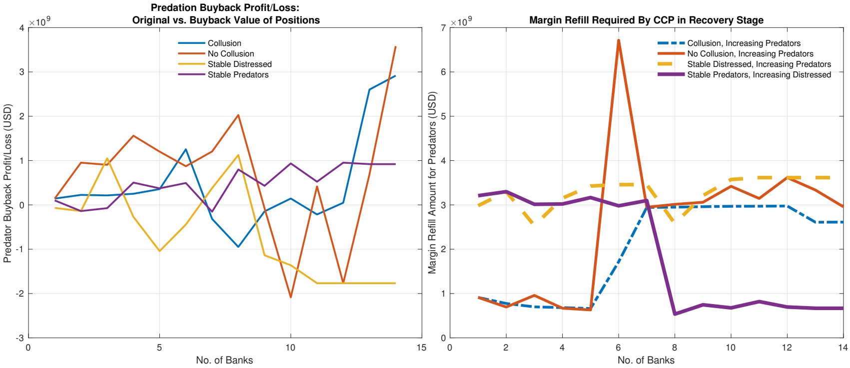

Figure: Under Decreasing Market Liquidity

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Simulation Results V: Pure vs. Hybrid Wealth for Decreasing Market Depth

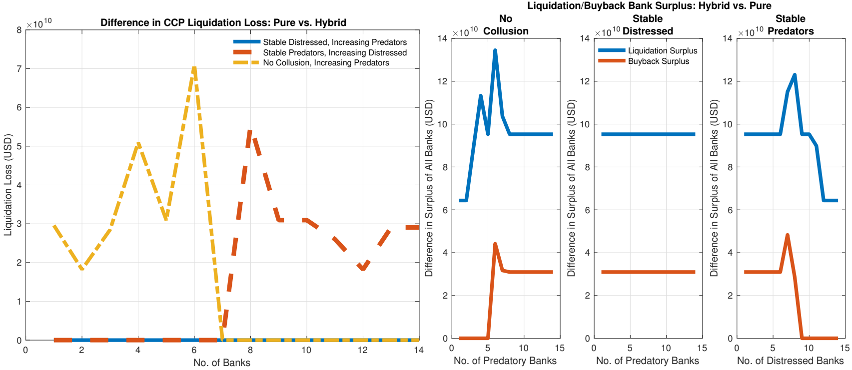

Figure: CCP Liquidation Loss & Aggregate Bank Liquidation/Buyback Surplus